# LAKE OSOYOOS

## INTEGRATED AQUATIC VEGETATION MANAGENT PLAN

2013

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## EXECUTIVE SUMMARY

Aquatic noxious weeds are a detriment to the health and water quality of Lake Osoyoos. This plan addresses these aquatic noxious weeds, and targets Eurasian watermilfoil for immediate control. Eurasian watermilfoil (Myriophyllum spicatum or Milfoil) is a submersed aquatic noxious weed that proliferates to form dense mats of vegetation in the littoral zone of lakes and reservoirs. It reproduces naturally by fragmentation, and is often spread as fragments that "hitch-hike" on boat trailers from one lake to another. Excessive fragmentation in Lake Osoyoos has been caused by boaters traveling through Milfoil infestations and the Milfoil harvesting activities occurring north of the border which cause large floating mats that follow the currents down the lake into US waters.

Milfoil can degrade the ecological integrity of a water body in just a few growing seasons. Dense stands of milfoil crowd out native aquatic vegetation, which in turn alters predator-prey relationships among fish and other aquatic animals. Milfoil can also reduce dissolved oxygen – first by inhibiting water mixing in areas where it grows, and then as oxygen is consumed by bacteria during decomposition of dead plant material. Decomposition of M. spicatum also adds nutrients to the water that could contribute to increased algal growth and related water quality problems. Further, dense mats of M. spicatum can increase the water temperature by absorbing sunlight, create mosquito breeding areas, and negatively affect recreational activities such as swimming, fishing, and boating.

Economically there is a significant cost to both reducing the spread of Milfoil and the continued growth of Milfoil in the Columbia River Watershed; of which Lake Osoyoos in an integral part. Various resources indicate that lake front property values can be reduced by 12-25% when impacted by Milfoil. In the Okanagan watershed on the Canadian side of the border, they routinely spend upwards of $300,000 on mechanical harvesting and rototilling for Milfoil control.

Lake Osoyoos, in Okanogan County Washington, is infested with Milfoil. Members of the Lake Osoyoos Association (LOA) realized the potential gravity of the aquatic weed problem and initiated a partnership with the Okanogan County Noxious Weed Control Board (OCNWCB) to apply for an Aquatic Weeds Management Fund grant through the Washington Department of Ecology (Ecology).

Since eradication is very difficult to achieve, and re-introduction is very likely, LOA and the community are organizing a management plan/device to implement ongoing monitoring and spot control. Immediate control measures are needed to protect the regionally significant resource areas of Lake Osoyoos from Milfoil and other invasive aquatic noxious weeds. Since Osoyoos flows into the Okanogan River, reducing milfoil infestations in the lake will contribute to reductions of milfoil in the Okanogan River as well as the Columbia River

This Integrated Aquatic Vegetation Management Plan (IAVMP) is a planning document developed to ensure that the applicant and the community have considered the best available information about the waterbody and the watershed prior to initiating control efforts. Members of LOA and OCNWCB worked in partnership to develop this IAVMP. To tackle the difficult task of generating community concern and action for an environmental issue, a core group of Association members formed a Steering Committee, which included OCNWCB staff members.

Through their work, the Steering Committee was able to educate the wider community about the problem, and inspire them to contribute feedback about potential treatment options. The Association ultimately agreed upon an integrated treatment strategy, which includes a combination of chemical, bio control, and manual, mechanical, and cultural control methods. While there is concern over mechanical methods because of excessive fragmentation which contributes to spread, it is realized that at some point it may be necessary, but it is not considered a first option of control.

This plan presents lake and watershed characteristics, details of the aquatic weed problems at Lake Osoyoos, the process for gaining community involvement, discussion of control alternatives, and recommendations for initial and ongoing control of noxious aquatic weeds threatening the lake.

## PROBLEM STATEMENT

Lake Osoyoos contains a total of 5,723 acres of which 2,046 acres are in the United States. The Milfoil, which is harvested in BC Waters, is spread downstream to the US side of the lake and ultimately into the Columbia River Watershed. This, and the current outbreak of Milfoil on the Lake pose a continuing threat of infestation to the watersheds of the Okanogan River and on to the Columbia River. The current outbreak of Milfoil on the lake poses a nuisance, economic, and safety threat to lakeside residents, recreational users, sports fishermen, boaters, and agricultural profitability. This plan will focus on the United States waters. Given that Lake Osoyoos is a main watershed for the Okanogan River which flows downstream to the Columbia, controlling invasive species here is a high priority.

Due to prolific growth of several species of dense, invasive aquatic noxious weeds, Lake Osoyoos is in danger of losing its aesthetic beauty, its wildlife habitat, and its recreational attributes as well as potentially decreasing the profitability of agricultural production. If left untreated, the worst of these weeds, Eurasian water milfoil (Myriophyllum spicatum), will further displace native aquatic vegetation, preventing most recreational uses and eliminating badly needed wildlife habitat. As Engle (Engle 1987) and Newroth (Newroth 1985) point out, there are negative effects for sport fish species such as Large Mouth Bass and Salmonids via reduced spawning success. More specifically, Milfoil can reduce water quality via a number of mechanisms, including increased nutrient loadings; reduce dissolved oxygen and changes in water temperature (Bates et al. 1985; Madsen 1997). In the summer of 2012, there was a significant fish kill in Lake Osoyoos of returning Sockeye salmon created by both the reduction of oxygen and high temperatures which created good conditions for the Columnaris bacteria which Washington Department of Fish and Wildlife (WDFW) confirmed as the of cause of the salmon kill. There will be long-term financial and recreational loss and the loss of conservation areas, all affecting watershed residents and other members of the public who use the lake for recreation and angling purposes. Increasing development in the area is likely to increase the number of people using the lake in coming years, which accelerates the magnitude of the loss of beneficial uses to the community.

The shallow shoreline areas of Lake Osoyoos provide an excellent habitat for aquatic plants and wildlife. Aggressive, non-native Eurasian water milfoil (milfoil) has invaded the lake and is colonizing much of the near-shore aquatic habitat. The dense submersed growth of milfoil has begun to cause a significant deterioration in the quality of the lake and its value to the community. The boat launch area has dense patches of milfoil, which can spread to other lakes by fragments on boat trailers. Milfoil patches have been found crowning the water surface in areas that are 15’-18’ in depth, and fragmentation by boaters is causing its further spread.

Milfoil is the most significant submersed invasive threat but other noxious weeds have also invaded Lake Osoyoos. These include Fragrant water lily (Nymphaea odorata), Purple loosestrife (Lythrum salicaria), Curlyleaf pondweed (Potamogeton crispus) and Yellow flag iris (Iris pseudacorus). All of these species are considered noxious weeds as listed in WAC 16-750. None of the native aquatic plants in the system are a management issue at this time. The native plants provide important benefits to the aquatic system and are not impeding any of the recreational uses of the lake. Removing the noxious invaders will reduce the degradation of the system and allow the dynamic natural equilibrium to be re-established.

Unfortunately, these invasive plants concentrate in the near shore zone which is also that portion of the lake that is valued and utilized most by lake residents and visitors. Dense weed growth poses a threat to swimmers, and the portion of the lake where people can fish is shrinking. Milfoil, Curly leaf pondweed and Fragrant water lilies foul fishing gear, motors, and oars. It is no longer possible to troll through large portions of the lake.

As a group these invasive plants:

- Pose a safety hazard to swimmers and boaters by entanglement

- Snag fishing lines and hooks, eventually preventing shoreline fishing
- Crowd out native plants, creating monocultures lacking in biodiversity
- Significantly reduce fish and wildlife habitat, thereby weakening the local ecosystem as well as degrading wildlife and wildlife viewing opportunities
- Pose a threat to adjoining ecosystems
- Impact oxygen levels in the lake
- Threaten a re-emerging Sockeye salmon run
- Pose a threat to the profitability of agriculture

The Lake Osoyoos Association has worked diligently to control invasive weeds through non chemical means and without the large scale use of a mechanical harvester. They have not been able to meet the current challenge of controlling such widespread infestations or of preventing re-infestation. Immediate action is necessary to control Eurasian water milfoil and other invasive weeds. If left unchecked, the lake will soon become heavily infested with aquatic weeds, severely degrading the lakes' ecosystem and making them even harder to eradicate with significant impact downstream. The Association recognizes that after initial control efforts, opportunity for re-infestation must be minimized.

## MANAGEMENT GOALS

The primary management goal is to control noxious aquatic weeds in Lake Osoyoos in a manner that allows sustainable native plant and animal communities to thrive; maintains acceptable water quality conditions, and facilitates recreational enjoyment of the lake.

There are four main strategies to ensure success in meeting this goal:

1. Involve the community in each phase of management process;
2. Use the best available science to identify and understand likely effects of management actions on aquatic and terrestrial ecosystems prior to implementation;
3. Review the effectiveness and sustainability of management actions;
4. Adjust the management strategy as necessary to achieve the overall goal.

## COMMUNITY INVOLVEMENT

From the very beginning, members of LOA and landowners in the surrounding area have demonstrated their commitment to improving their community and protecting the lake as well as the expansive natural areas around their homes. This section provides an overview of past, present, and future of community involvement.

### Community History

Osoyoos has a total perimeter of 29.8 miles. Lake Osoyoos is mainly fed by the Okanagan River watershed in Canada.

Most of the Okanagan River basin watershed lies north of the Canadian border, where its flow is regulated by four lakes along the river's mainstream. Most of these lakes are located north of the U.S.-Canada border except the 14,150-acre Osoyoos Lake, which straddles the border. The lower Okanogan River flows out of Osoyoos Lake (elevation 915' m.s.l.) at the city of Oroville and flows 79 miles southward to its confluence with the Columbia River (779' m.s.l.). The Similkameen River joins the Okanogan River just downstream of Oroville, where its flow is increased by an average of 400 percent. About 20 small tributary streams also drain into the Washington portion of the basin. Most of the tributaries are small or intermittent, contributing little to the overall flow of the lower Okanogan River.

Newspaper accounts state that Eurasian Milfoil was introduced into Okanagan Lake system in the early 1970's and has proven to be extremely disruptive to B.C's lake ecosystems.

The idea of having a Lake Osoyoos Association (LOA) began in October of 1983. The LOA was incorporated in 1984 with fifteen board members. The stated mission of the LOA was to represent the interests of its members in the stewardship of Lake Osoyoos.

At its first meeting in 1984 residents were polled as to their concerns. The continued growth of Milfoil was number one. The number two issue was water levels in the lake. At this time there were 39 paid members in the LOA.

The LOA participated in one of the first meetings in this area with the Washington Department of Ecology Interagency Task Force on Milfoil Control in December of 1983.

Much of the early work of the LOA concerned a dispute between the Department of Natural Resources (DNR) and the "line of ordinary high water." This issue was discussed for much of 1983 to 1987 with a final agreement after much input from the LOA in 1987. Also at this time there was concern regarding plans for the City of Vernon BC to dump untreated sewage into the Okanagan system.

In March of 1984, a trial of 2-4 D was tried in Lake Osoyoos on the U.S. side of the border. A newspaper article in the Osoyoos Times on March 24th stated that, "The U.S. Army Corps of Engineers, which is carrying out the tests, also believe the new way of applying 2-4 D could almost eliminate the problem of spreading milfoil from drifting weed segments." This was attempted in the belief of trying to stop the spread of milfoil downstream into the Okanogan River and ultimately the Columbia River. As John Spencer, then director of the Washington State Ecology Department stated about that attempt, "We were wrong." The spread downstream continued.

1984 also marked the first use of a "weed harvester" on the Canadian side of the lake. At this time the Department of Ecology view of harvesting was, "...the machines as something that probably worsens attempts downstream to handle milfoil because harvesting breaks off more fragments that drift; then restart themselves further on."

The LOA supported improvement in the Boat Tax in the 1985 legislature. In April of 1985 the LOA also had support from the Army Corps of Engineers for continued use of 2-4 D which they (LOA) supported.
However, in August of 1985 the Eurasian Milfoil control program was suspended due to an injunction issued by the Federal Court.

Harvesting and now rotovation occur as the Canadians main method of dealing with Milfoil to this date. This despite much data that finds that harvesting, rotovation, wave action, and boat traffic all produce milfoil fragments. In fact, Crowell, Troeslrup Jr, Queen, and Perry (J. Aquat. Plant Manage. 32: 56-60) found that harvested plots had significantly "higher relative growth rates over the remaining field season," than did non-harvested areas.

An Osoyoos Times Newspaper article in July of 1987 stated "that after years of harvesting; ...the weeds have come back with a vengeance this year". In 1987, the budget for harvesting in the Okanagan watershed was $147,000. Today it is upwards of $500,000.

In a bit of an ironic twist, a University of Victoria student spent three summers (1984-1987) studying the possibility of using biological control methods to augment the mechanical control methods. To this day the Canadians only use mechanical means to deal with milfoil**.**

In 1984 the LOA supported the rebuilding of the Zosel Dam in Oroville as a way to better control lake levels.

After the 1987 Federal injunction against the use of 2-4 D and the settlement of the water level issues the LOA involvement in lake issues waned with the exception of dealing with how the international border on the lake would be marked in 1992, and with water quality monitoring. As a result of this, in 1994 the Department of Ecology determined that Lake Osoyoos was found to have high forms of the pesticide DDT; which were found at levels that violate state standards.

In 1996 there were 200 lake shore land owners on Lake Osoyoos. In the LOA's 2011 membership drive membership brochures were sent out to 250 lake shore owners.

In 2005-2006 the LOA was involved in issues of property rights and lake shore development. There have been recent developments on the US side of Lake Osoyoos with the establishment of the Veranda Beach Resort on close to 900 acres, much of it set back from the lake with access to the lake.

Members of the LOA have conducted bi-monthly water quality testing from May to September on the lake since 2007. The ongoing Milfoil problem has also been an area of concern and members had repeatedly contacted OCNWCB for information regarding control options.

In 2010, the LOA along with the OCNWCB wrote and applied for a Department of Ecology Planning grant. In 2011, at their annual meeting they had representatives from the Department of Ecology, OCNWCB, and Enviroscience present to discuss treatment options, with a focus on bio-controls.
In 2011 and 2012 the LOA and OCNWCB participated in cross border meetings with members of the Christina Lake Water Society. In addition, LOA members participated in the Osoyoos Water Science Forum in 2011, in Osoyoos, B.C. During the summer of 2012 the LOA met with a representative of Enviroscience in Oroville to talk about what would be involved in doing a substantial pilot project on the lake along the U.S. Canadian Border. They even received a plan by Enviroscience for such a project. However, at that time they could not get the Canadians to agree to split costs for the project and there were questions raised on the Canadian side of the border regarding the re-introduction of the weevils back into the lake of origin and possible introduction of other invasive species.

During 2012 the LOA and OCNWCB had several meetings with the Mayor of Osoyoos, B.C. and the Okanagan Basin Water Board to talk about the use of biological control. This discussion even talked about the possibility of raising and propagating weevils in their Sterile Insect Release facility. While there was much interest in this possibility initially from the Canadians, problems with the economic sustainability of the SIR facility tabled further discussion. However, during the course of the Ecology grant work, the LOA was able to work with the Oroville High School Science Lab to perform a small pilot project regarding rearing and releasing the weevil on its own.

**Community commitment**

Community outreach and involvement by the Lake Osoyoos Association has included the establishment of a LOA webpage (lakeosoyoosassoc.com), monthly newsletters from April to November, public meetings, dissemination of educational materials at Oroville's May Day celebration, partnership with the local High School science lab in keeping fish tanks with milfoil and weevils. In addition, the LOA has distributed Milfoil signage at public boat launches on the lake. During weekend in the summer of 2013, informational brochures regarding Eurasian watermilfoil, and Quagga and Zebra mussels distributed to recreationists in both of Oroville's City Parks. LOA members have participated in WALPA and NALMS conventions. The LOA had a large membership drive sending information to all landowners on the U.S. side of the lake, including Canadians.

In 2012 the LOA worked to develop a sustainable partnership with our neighbors north of the border. We participated in their Water Science Forum which was sponsored by the Town of Osoyoos, and several other organizations on both sides of the border. During this time we had substantive meetings with the Okanagan Water Board Society and the Mayor of Osoyoos. These discussions talked about common concerns around milfoil and included the discussion of using biological control.

At the end of the summer of 2012 the town of Osoyoos in a good faith effort contributed a substantial amount of money to our LOA to work on water quality efforts in the lake.

During the summer of 2012 LOA members, with the guidance of Jennifer Parsons from Ecology, began to identify and collect weevils for the purpose of attempting to propagate weevils. With money from our planning grant and with the assistance of Anna Lyon of the OCNWCB, we purchased ten twenty gallon fish tanks, aerators, lights, and thermometers, and set up a lab in the Oroville High School science lab. We followed the practices outlined by Alfred F. Cofrancesco, Holly Crosson, August 1999, Vol A-99-3, US Army Corps of Engineers, and reviewed the process published by Jennifer Parsons, the Department of Ecology, from her work in 2002-2003. All practices were similar in nature and easily modified to suit individual projects.

LOA community members then went out on the lake in July 2012, spending several days, and collected weevils, took them and milfoil to the fish tanks in the science lab. Propagation was confirmed by Jennifer Parsons in August. LOA members then took 15+ weevils to a small protected area with dense milfoil. The area was marked with a buoy. Later monitoring of this area noted a distinctive lowering of milfoil in the water column.

Also in July to August 2012 Sockeye Salmon passing through the lake were dying off in large numbers. The LOA contacted the Fish and Wildlife Department who sent an officer out and documented the kill as due to the Columnaris bacteria which affects their gills.

The LOA also participated in discussion regarding the renewal of the cross-border agreement concerning lake levels for 2013.

## PUBLIC CONSENSUS

The increasing amount of Eurasian watermilfoil and other aquatic noxious or nuisance weeds has caused a community to agree that control efforts must occur to ensure recreational safety and water quality. To date, there have been no objections to the proposed project or for the proposed methods of treatment from local landowners. Every person who has learned about the project has voiced support.

Given the community's small size, and their dedication and enthusiasm for keeping Lake Osoyoos healthy, none of the Steering Committee members anticipate resistance to the proposed project prior to, during, or after implementation.

## CONTINUING COMMUNITY EDUCATION

The Lake Osoyoos Association will offer the means by which the community will receive ongoing education. In addition, the Steering Committee for the proposed aquatic weed removal project will remain intact, although membership on the Steering Committee is likely to change over time. To ensure that community education is consistent with best available science and water quality standards, the Association will continually educate themselves by maintaining contact with aquatic professionals. Information will be disseminated through community club meetings, watershed mailings when applicable, and the Association newsletter. Additionally, the Association will work to recruit new lake monitors and surveyors. An Association website was developed and now includes information about Eurasian watermilfoil. All of the documents and PowerPoint presentations generated by the Steering Committee meetings will be available for download.

The public education program for Lake Osoyoos will consist of three elements that will be implemented concurrently:

1. **Noxious Aquatic Weeds Prevention and Detection** - Initial control efforts are only worth doing if future infestations are prevented, or detected and controlled soon after detection. Since the re-introduction of milfoil and other weeds to Lake Osoyoos is almost certain, a prevention and detection plan is essential.

The LOA web site will be used to distribute educational materials. Steering Committee members will compile published materials and generate literature specifically related to Lake Osoyoos to make it available to all lake residents each year at the beginning of the growing season on the LOA website. Pictures for identification purposes will be added to the web site to raise awareness among individual landowners of potential non-native invasive plants. A better-educated community of residents and lake-users will be more likely to identify and report noxious aquatic weeds and other potential problems. These educational materials will also be available through area businesses that support recreational opportunities on the lake.

2. Lake Stewardship Education Program - All residents on the Lake affect the water quality of Lake Osoyoos, although sometimes the cause and effect relationships are not readily apparent. Educating community members and other lake users will illuminate the relationship between human behaviors and water quality. Each lake resident will be provided information on how to reduce the amount of pollutants entering the lake from their property. Property owners with lakeside lots will be provided information on lake-friendly landscaping, subsequently ensuring a healthier lake environment. Improved signs will be posted at the boat ramp to inform lake-users of the problems caused by noxious aquatic weeds and how to prevent spreading them from lake to lake.

3. Two aquatic weed surveys each growing season. Volunteers (community members) will undergo training with lakes/aquatic plant specialists prior to conducting surveys. There is a core of committed volunteers who will be trained in plant collection using a double sided rake. They will be trained to survey the lake bottom using this technique to complement visual surveys from the surface and to take samples for identification

## WATERSHED AND WATERBODY CHARACTERISTICS

### Watershed Characteristics

The Okanogan River Watershed encompasses about 2,100 square miles in Washington State. This watershed extends north and south from the Canadian border to the Columbia River. The physical northern boundary of the watershed is actually in the Canadian province of British Columbia where another approximately 6,000 square miles is located. Mean precipitation over the Okanogan River Watershed is 15 inches.

The Okanogan River flows through Osoyoos Lake, which extends across the international boundary, and continues southward to empty into the Columbia River near Brewster. However, an even greater inflow from Canada is from the Okanogan's major tributary, the Similkameen River. The Similkameen crosses the border west of the Okanogan and enters the Okanogan River near the south end of Osoyoos Lake. About 2.1 million acre-feet of water enters the watershed from Canada as streamflow; about 75 percent of this amount is from the Similkameen River. The outflow from the watershed at Brewster is estimated to be 2.2 million acre-feet.

This watershed is within the Columbia Basin, Cascades, and Northern Rockies ecoregions. The eastern and western boundaries of the basin are steep, jagged ridgelines at elevations ranging from 1,500 feet to more than 5,000 feet above the basin floor. The floodplain of the Okanogan River valley averages about a mile in width, and descends from an elevation of about 920 feet at the international boundary to about 780 feet at the river's confluence with the Columbia River. Osoyoos Lake occupies the northern most 4 miles of the valley floor and extends several miles into Canada.

The soils in the watershed include shallow to moderately deep sandy loam and silt loam. These soils are formed from volcanic ash and pumice (ejected from Glacier Peak to the west centuries ago), glacial till and outwash, alluvium, lake sediments, and wind-laid silts.

There are approximately 32,855 people living in the Okanogan Basin. The primary population centers are Omak and Okanogan. The majority of people live in unincorporated areas. The largest land uses in the basin are forested lands (51%) and agricultural lands (39%).
(Okanogan County Planning & Development website)

**Waterbody Characteristics**

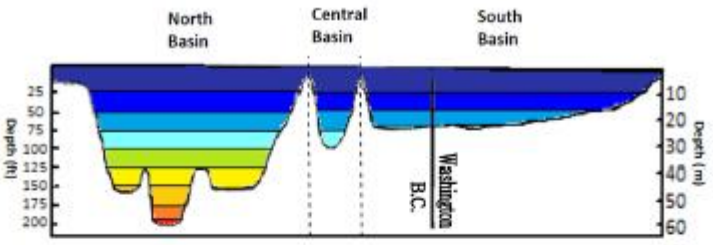


Figure 2. Cross-sectional view of Osoyoos Lake, illustrating depths for the north basin, central basin, and south basin. Modified from Hyatt et al. (personal communications, 2007). Note that the south basin is shallower here than in Figure 3, which was based on earlier bathymetric data.

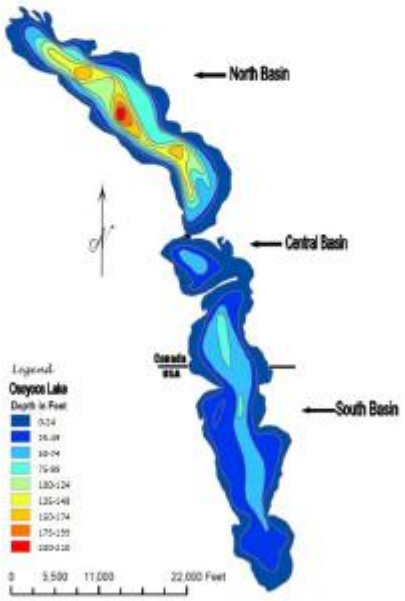


Figure 3. Bathymetry contour map of Osoyoos Lake. Updated from ArcGIS and Anglers Atlas, 2002. Map survey conducted August 1966 by the Province of British Columbia.

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This big beautiful lake is ten miles long, covers 5729 surface acres and is split by the United States / Canadian border. British Columbia owns 3693 of these surface acres and the rest are in Washington State. Osoyoos has a total perimeter of 29.8 miles. Lake Osoyoos is mainly fed by the Okanagan River watershed in Canada.

Most of the Okanagan River basin watershed lies north of the Canadian border, where its flow is regulated by four lakes along the river's mainstream. Most of these lakes are located north of the US / Canada border except the 5,800 –acre Osoyoos Lake which straddles the border. The lower Okanogan River flows out of Osoyoos Lake

(elevation 915' msl) at the city of Oroville and flows 79 miles southward to its confluence with the Columbia River (779' msl). The Similkameen River joins the Okanogan River just downstream of Oroville where its flow is increased by an average of 400%. About 20 small tributary streams also drain the 2,600 miles of the Washington portion of the basin. Most of the tributaries are small or intermittent, contributing little to the overall flow of the lower Okanogan River.

Osoyoos is touted as the warmest lake in Canada; the water's temperature reaches a bath tub warmth of 78 – 80 F in August. In August, the air temperature can soar to the low 100's.

Given that the lake is in the Sonora Desert region the lake can quickly develop high winds; in 2007 there was a sustained wind burst of 71 MPH. In the summer of 2012 there were sustained winds of 53 MPH. When the milfoil is blooming the wave action created by these large winds can create more fragments floating on the waves, further distributing the milfoil.

Water levels of Lake Osoyoos have been regulated by the IJC (International Joint Commission) since 1946, when it approved alterations to an existing dam downstream from the lake. Under orders of the IJC, a new structure was constructed in 1987 to replace the dam. The orders set maximum and minimum lake elevations of 911.5 and 909 feet during normal years. During a drought year, water may be stored to lake elevations as high as 913 feet.

The five kinds of fish in the lake make it a hit with fishermen, with species including Large Mouth Bass, Trout and Kokanee. In the summer of 2012, there was a large sockeye salmon return (upwards of 300,000). Due to the high water temperatures and low oxygen levels, especially on the US side of the border, hundreds of these Sockeye developed a Columnaris bacteria and died off.

**Water Quality**

*Data reported by the Washington State Department of Ecology in 1997:*
*TROPHIC STATUS*
*Estimated Trophic State: Mesotrophic*
*Mean Trophic State Index (Secchi): 41 (Oligo-mesotrophic)*
*Mean Trophic State Index (Total Phosphorus): 42 (Mesotrophic)*
*Mean Trophic State Index (Chlorophyll a): 42 (Mesotrophic)*

*SUMMARY AND EXPLANATION OF TROPHIC STATE ASSESSMENT*
*Although TSI values suggest an oligo-mesotrophic assessment, summertime hypolimnetic DO concentrations show a lake that is nearly anoxic in the hypolimnion. All factors considered, a mesotrophic assessment is most suited for Lake Osoyoos.*

**Fish and Wildlife Communities**

Lake Osoyoos and its surrounding habitats support a variety of fish, birds, and animals by providing nesting, forage, and cover. According to Washington Department of Fish and Wildlife (WDFW) the resident fish species in Lake Osoyoos include anadromous salmonids, pygmy whitefish; rainbow trout; sockeye; spring Chinook; summer Chinook; summer steelhead; and multiple species of sunfish.

Mink, beaver, muskrat, ducks, loons, lizards, frogs, and salamanders are also present in Lake Osoyoos. Geese, Bald Eagle, Common Loon and Western Grebe are also associated with the lake which is in their migratory path.

**Beneficial and Recreational Uses**

Lake Osoyoos and its surroundings support a variety of uses to humans. Recreational activities include swimming, fishing, boating, bird watching, and wildlife viewing. Residents access the lake for these activities from any of the small private docks around the lake associated with the residential parcels. A public boat launch maintained by the City of Oroville allows everybody to benefit from this beautiful resource as well.

**Characterization of Aquatic Plants in Lake Osoyoos**

The plant communities in, and around Lake Osoyoos, represent a diverse set of ecotypes. Hundreds of species occur in specific habitats represented in the area. The aquatic vegetation serves a wide array of functions, such as supporting food chains, providing habitat for a variety of animal species, intercepting sediment and removing toxic compounds from runoff, and providing erosion control/bank stabilization for lakes and streams.

The most recent comprehensive aquatic plant survey of Lake Osoyoos occurred in 2011 and was performed by DOE. Unfortunately there is no corresponding GIS information of the survey. A Eurasian Watermilfoil survey was conducted in 2010, by Aquatechnex, to determine the extent of infestations. The Lake Osoyoos Association membership has also provided invaluable assistance in detecting emergent vegetation.

Thirty-six plant species (see Table 1) were identified at Lake Osoyoos, including thirteen emergent types, four floating types, and nine sub-mergent types. Emergents are plants that are rooted in the sediment at the water's edge but have stems and leaves which grow above the water surface. Floating rooted plants are rooted in the sediment and send leaves to the water's surface. Sub-mergent plants are either freely-floating or are rooted in the lake bottom but grow within the water column.

Lake Osoyoos continues to support milfoil throughout the littoral zone, including areas of dense concentration. Lythrum salicaria is scattered on the East and South end of the Lake. No significant infestations have been found in the core of the wetland. Populations and distribution of L. salicaria have been partially contained by repeated releases of biological controls

Plant surveys of Lake Osoyoos were carried out in 1993, 2005, 2009, 2010, and 2011. Native plants include several pondweed species, Cattails, sedges, Coontail and Northern watermilfoil. The Washington Natural Heritage Program (WNHP) has a Natural Heritage Information System database for rare plant species, select rare animal species, and high quality wetland and terrestrial ecosystems. This database has species in the vicinity of Lake Osoyoos and Okanogan County (See Attached).

**Noxious Aquatic Weeds in Lake Osoyoos**

Non-native species include several Washington State listed noxious weeds, such as Yellow flag iris, Purple loosestrife, Curly leaf pondweed, Eurasian watermilfoil, Fragrant water lily and Reed canary grass. These species will be the focus of the plant management efforts on Lake Osoyoos. The term "noxious weed" refers to those non-native plants that are legally defined by Washington's Noxious Weed Control Law (RCW 17.10) as highly destructive, competitive, or difficult to control once established. Noxious weeds have usually been introduced accidentally as a contaminant, or as ornamentals. Non-native plants often do not have natural predators (i.e. herbivores, pathogens) or strong competitors to control their numbers as they may have had in their home range.

WAC 16.750 sets out three classes (A, B, C) of noxious weeds based on their distribution in the state, each class having different control requirements. County Weed Boards are given some discretion as to setting control priorities for Class B and C weeds. Eurasian watermilfoil and Purple loosestrife are both Class B Noxious Weeds, while Fragrant water lily, Curly leaf pondweed, Reed canarygrass and Yellow flag iris are Class C Noxious Weeds.

**Eurasian watermilfoil (Myriophyllum spicatum)**

Eurasian watermilfoil is native to Europe, Asia, and North Africa and also occurs in Greenland (Washington State Noxious Weed Control Board, 1995). The oldest record of Eurasian watermilfoil in Washington is from a 1965 herbarium specimen collected from Lake Meridian, King County. It was first identified causing problems in the 1970s in Lake Washington and proceeded to move down the I-5 corridor, probably transported to new lakes on boats and trailers. Eurasian watermilfoil is among the worst aquatic pests in North America. M. spicatum is a

submersed, perennial aquatic plant with feather-like leaves. It usually has 12 to 16 leaflets (usually more than 14) on each leaf arranged in whorls of 4 around the stem. Leaves near the surface may be reddish or brown. Sometimes there are emergent flower stalks during the summers that have tiny emergent leaves. This plant forms dense mats of vegetation just below the water's surface. In the late summer and fall, the plants break into fragments with attached roots that float with the currents, infesting new areas. Disturbed plants will also fragment at other times of the year. A new plant can start from a tiny piece of a Milfoil plant. Milfoil starts spring growth earlier than native aquatic plants, and thereby gets a "head start" on other plants. Eurasian watermilfoil can degrade the ecological integrity of a water body in just a few growing seasons.

Dense stands of Milfoil crowd out native aquatic vegetation, which in turn alters predator/prey relationships among fish and other aquatic animals. Eurasian watermilfoil can also reduce dissolved oxygen – first by inhibiting water mixing in areas where it grows, and then as oxygen is consumed by bacteria during decomposition of dead plant material. Decomposition of M. spicatum also releases phosphorus and nitrogen to the water that could increase algal growth. Further, dense mats of Eurasian watermilfoil can increase water temperature by absorbing sunlight, raise the pH, and create stagnant water mosquito breeding areas. Eurasian watermilfoil will negatively affect recreational activities such as swimming, fishing, and boating. The dense beds of vegetation make swimming dangerous, snag fish hooks, and inhibit boating by entangling propellers or paddles and slowing the movement of boats across the water. In Osoyoos Lake, M. spicatum is generally moderate in density, but there are an increasing amount of dense infestations.

It is likely that the non-native milfoil infestations will continue to expand if left untreated, dramatically increasing negative impacts to the beneficial uses of Lake Osoyoos.

**Purple loosestrife (Lythrum salicaria)**
Purple loosestrife is native to Europe and Asia and was introduced through ship ballast water to the Atlantic Coast in the mid-1800s (Washington State Noxious Weed Control Board, 1997). In Washington, Purple loosestrife was first collected from the Seattle area in 1929 from Lake Washington. Purple loosestrife is a perennial that can reach 9 feet tall with long spikes of magenta flowers. The flowers usually have 6 petals, and the stems are squared-off.

Vigorous plants can produce over 2 million tiny, lightweight seeds (120,000 per spike) that are easily spread by waterfowl and other animals (Washington State Noxious Weed Control Board, 1997). Although a prolific seeder, purple loosestrife can also spread through vegetative production by shoots and rhizomes as well as by root fragmentation. It has a woody taproot with a fibrous root system that forms a dense mat, keeping other plants from establishing in a space.

Purple loosestrife disrupts wetland ecosystems by displacing native or beneficial plants and animals. Waterfowl, fur-bearing animals, and birds vacate wetland habitat when native vegetation is displaced by Purple loosestrife. Loss of native vegetation results in decreased sources of food, nesting material, and shelter for indigenous waterfowl and animals. Economic impacts are high in agricultural communities when irrigation systems are clogged or when wet pastures are unavailable for grazing. Purple loosestrife is aggressive and competitive, taking full advantage of disturbance to natural wetland vegetation caused by anthropogenic alterations of the landscape. Seed banks build for years since seeds may remain viable for up to 3 years. Mono-specific stands are long-lived in North America as compared to European stands, illustrating the competitive edge loosestrife has over other plant species. Purple loosestrife will disperse further up into the wetland if not controlled.

**Fragrant water lily (Nymphaea odorata)**
This noxious weed is native to the eastern half of North America (Washington State Noxious Weed Control Board, 2001b). It was probably introduced into Washington during the Alaska Pacific Yukon Exposition in Seattle in the late 1800's. It has often been introduced to ponds and lakes because of its beautiful, large white or pink (occasionally light yellow), many-petaled flowers that float on the water's surface, surrounded by large, round

green leaves. The leaves are attached to flexible underwater stalks rising from thick fleshy rhizomes. Adventitious roots attach the horizontal creeping and branching rhizomes.

This aquatic perennial herb spreads aggressively, rooting in murky or silty sediments in water up to 7 feet deep. It prefers quiet waters such as ponds, lake margins and slow streams and will grow in a wide range of pH. Shallow lakes are particularly vulnerable to being totally covered by Fragrant water lilies. Water lily spreads by seeds and by rhizome fragments. A planted rhizome will cover about a 15-foot diameter circle in five years (Washington State Noxious Weed Control Board, 2001b). This can reduce the important open water component in the littoral zone of Lake Osoyoos.

When uncontrolled, this species tends to form dense mono-specific stands that can persist until senescence in the fall. Mats of these floating leaves prevent wind mixing and extensive areas of low oxygen can develop under the water lily beds in the summer. Water lilies can restrict lakefront access and hinder swimming, boating, and other recreational activities. Fragrant water lily infestations are growing increasingly dense in the lower portion of Lake Osoyoos. Recreational activities such as boating, fishing, and swimming will become more difficult. Even canoes can have great difficulty moving across dense floating mats of Fragrant water lily, not to mention entanglement with propellers of boat motors.

**Yellow flag iris (Iris pseudacorus)**
Yellow flag iris is native to mainland Europe, the British Isles, and the Mediterranean region of North Africa (Washington State Noxious Weed Control Board, 2001a). This plant was introduced widely as a garden ornamental and has also been used for erosion control. The earliest collection in Washington is from Lake McMurray in Skagit County in 1948 (Washington State Noxious Weed Control Board, 2001a). The yellow flowers are a distinguishing characteristic, but when not blooming, it may be confused with Cattail (Typha sp.) or Broad-fruited bur-reed (Sparganium eurycarpum).

Yellow flag iris spreads by both rhizomes and seeds. The plants produce large fruit capsules and corky seeds in the late summer; these seeds are then easily dispersed along the water channel. Several hundred flowering plants may be connected by rhizomes. Yellow flag iris can spread to form dense stands that can exclude even the toughest of our native wetland species, such as Typha latifolia (cattail). This noxious weed has already infested a large area at the south end of the lake and threatens to disperse further up into the wetland if not controlled. In addition to decreasing plant diversity, Yellow flag iris can also alter hydrologic dynamics through sediment accretion along the shoreline. It has been observed in the Okanogan River, both south of Lake Osoyoos and at the delta of Columbia River.

# AQUATIC PLANT CONTROL ALTERNATIVES

This section outlines common methods used to control aquatic weeds. Much of the information in this section is quoted directly from the Ecology's website:
http://www.ecy.wa.gov/programs/wq/plants/management/index.html

Additional information is derived from the field experience of the Okanogan County Noxious Weed Control Board, qualified WSDA licensed aquatic herbicide applicators, and conversations with WDFW and DNR aquatic specialists regarding various non-chemical control methods.

Control/eradication methods discussed herein include Aquatic Herbicide, Manual Methods, Bottom Screens, Diver Dredging, Biological Control, Rotovation, Cutting, Harvesting, and Drawdown.

## AQUATIC HERBICIDES
### Description of Method

Aquatic herbicides are chemicals specifically formulated for use in water to eradicate or control aquatic plants. Herbicides approved for aquatic use by the United States Environmental Protection Agency (EPA) have been reviewed and considered compatible with the aquatic environment when used according to label directions. However, individual states may also impose additional constraints on their use.

Aquatic herbicides are sprayed directly onto floating or emergent aquatic plants, or are applied to the water in either a liquid or pellet form. Systemic herbicides are capable of killing the entire plant by translocation from the foliage or stems and killing the root. Contact herbicides cause the parts of the plant in contact with the herbicide to die back, leaving the roots alive and capable of re-growth (chemical mowing). Non-selective herbicides will generally affect all plants that they come in contact with, both monocots and dicots. Selective herbicides will affect only some plants (usually dicots – broad leafed plants like Eurasian watermilfoil will be affected by selective herbicides whereas monocots like Brazilian elodea and our native pondweeds may not be affected).

Because of environmental risks from improper application, aquatic herbicide use in Washington State waters is regulated and has certain restrictions. The Washington State Department of Agriculture must license aquatic applicators. In addition, because of a March 2001 court decision (Federal 9th Circuit District Court), coverage under a discharge permit called a National Pollutant Discharge Elimination System (NPDES) permit must be obtained before aquatic herbicides can be applied to some waters of the U.S. This ruling, referred to as the Talent Irrigation District decision, has further defined Section 402 of the Clean Water Act. Ecology has developed a general NPDES permit which is available for coverage under the Washington Department of Agriculture for the management of noxious weeds growing in an aquatic situation and a separate general permit for nuisance aquatic weeds (native plants) and algae control. For nuisance weeds
(native species also referred to as beneficial vegetation) and algae, applicators and the local sponsor of the project must obtain a NPDES permit from the Washington Department of Ecology before applying herbicides to Washington water bodies.

### Aquatic Herbicides Labeled for use in Washington State (see Appendix D for herbicide labels) based on active ingredient.

**Aquatic labeled Glyphosate** - This systemic nonselective herbicide is used to control floating-leaved plants like Water lilies and shoreline plants like Purple loosestrife and Yellow flag iris. It is generally applied as a liquid to the leaves. It does not work on underwater plants such as Eurasian watermilfoil. Although glyphosate is a non-selective herbicide, a good applicator can somewhat selectively remove targeted plants by focusing the spray only on the plants to be removed. Plants take several weeks to die. A repeat application is often necessary to remove plants that were missed during the first application. **Note**: there are now several glyphosate products available, but with different trade names now that the patent has expired. Additional surfactants are always added by the applicator for the aquatic formulations to improve the penetration of the leaf cuticle and help the herbicide stay on the plant long enough to be effective. Those that may be used for emergent weed control include X-77, LI-700, and R-11 as approved by the SEPA process. Only LI-700 is approved for Fragrant water lily control under the NPDES permit.

**Aquatic labeled 2,4-D** – is a systemic, selective herbicide used for the control of Eurasian watermilfoil and other broad-leaved species. It has several aquatic formulations which can be utilized under different circumstances.

**Aquatic labeled Fluridone -** is a slow-acting systemic herbicide used to control Eurasian watermilfoil and other underwater plants. It may be applied in pelleted form or as a liquid. Fluridone can show good control of submersed plants where there is little water movement and an extended time for the treatment. Its use is most applicable to whole-lake or isolated bay treatments where dilution can be minimized. It is not effective for spot treatments. It may take six to twelve weeks before the dying plants fall to the sediment and decompose. When used to manage Eurasian watermilfoil, fluridone is applied several times during the summer to maintain a low, but consistent concentration in the water. Although fluridone is considered to be a non-selective herbicide, when used at low concentrations, it can be used to selectively remove Eurasian watermilfoil. Some native aquatic plants, especially pondweeds, are minimally affected by low concentrations of fluridone.

**Aquatic Labeled dipotassium salt** of **Endothall -** is a fast-acting non-selective contact herbicide, which destroys the vegetative part of the plant but does not kill the roots. It can be applied in a granular or liquid form. Generally endothall compounds are used primarily for short-term (one season) control of a variety of aquatic plants. However, there has been some recent research that indicates that when used in low concentrations, it can be used to selectively remove exotic weeds, leaving some native species relatively unaffected. Because it is fast acting, it can be used to treat smaller areas effectively. There is **water use restrictions** associated with the use of **dipotassium salt** of **endothall** in Washington.

### Advantages

- Aquatic herbicide application can be less expensive and more effective than other aquatic plant control methods.

- Aquatic herbicides are easily applied around docks and underwater obstructions.

- 2,4-D DMA & 2,4-D BEE have been shown to be effective in controlling smaller infestations (not lake-wide) of Eurasian watermilfoil in Washington, and could also be used on the purple loosestrife and yellow flag iris.

- Washington has had some success in eradicating Eurasian watermilfoil from some smaller lakes (320 acres or less) using fluridone.

- Glyphosate is the recommended chemical for fragrant water lily control

### Disadvantages

- Generally, most aquatic herbicides have use restrictions, with irrigation restrictions being the most common. Some herbicides have swimming, drinking, fishing, irrigation, and water use restrictions.

- Herbicide use may have unwanted impacts to people who use the water and to the environment.

- Non-targeted plants as well as nuisance plants may be controlled or killed by some herbicides.

- Depending on the herbicide used, it may take several days to weeks or several treatments during a growing season before the herbicide controls or kills treated plants.

- Rapid-acting herbicides may cause low oxygen conditions to develop as plants decompose. Low oxygen can cause fish kills.

- To be most effective, generally herbicides must be applied to rapidly growing plants.

- As with any pesticide, some expertise in using herbicides is necessary in order to be successful and to avoid unwanted impacts.

- Many people have strong feelings against using chemicals in water.

- Some cities or counties may have policies forbidding or discouraging the use of aquatic herbicides.

### Permits

A NPDES permit is needed. Both the noxious and nuisance NPDES permits require the development of Integrated Aquatic Vegetation Management Plans (IAVMP) by the third year of control work. Monitoring of herbicide levels in the water may be required, whether the chemical has been applied directly to the water or along the shoreline where it may have gotten into the adjacent water. For emergent noxious weed control, the applicator must apply to the Washington Department of Agriculture (WSDA) for coverage under their NPDES permit each treatment season. There is no permit or application fee to obtain NPDES coverage under Agriculture's permit for Noxious Weeds.

### Costs

Costs associated with chemical control of aquatic weeds will vary by site, timing and the chemical used. Generally costs will be between $200 and $1,500 per acre depending on elements included in the application, such as notifications and advertising, as well as the actual cost of the application.

## MANUAL METHODS

### Hand-Pulling

Hand pulling of aquatic plants is similar to pulling weeds out of a garden. It involves removing entire plants (leaves, stems, and roots) from the area of concern and disposing of them in an area away from the shoreline. In water less than three feet deep no specialized equipment is required, although a spade, trowel, or long knife may be needed if the sediment is packed or heavy. In deeper water, hand pulling is best accomplished by divers with SCUBA equipment and mesh bags for the collection of plant fragments. Some sites may not be suitable for hand pulling such as areas where deep flocculent sediments may cause a person hand pulling to sink deeply into the sediment.

### Cutting

Cutting differs from hand pulling in that plants are cut and the roots are not removed. Cutting is performed by standing on a dock or on shore and throwing a cutting tool out into the water. A non-mechanical aquatic weed cutter is commercially available. Two single-sided, razor sharp stainless steel blades forming a "V" shape are connected to a handle, which is tied to a long rope. The cutter can be

thrown about 20 – 30 feet into the water. As the cutter is pulled through the water, it cuts a 48-inch wide swath. Cut plants rise to the surface where they can be removed. Washington State requires that cut plants be removed from the water. The stainless steel blades that form the V are extremely sharp and great care must be taken with this implement. It should be stored in a secure area where children do not have access.

### Raking

A sturdy rake makes a useful tool for removing aquatic plants. Attaching a rope to the rake allows removal of a greater area of weeds. Raking literally tears plants from the sediment, breaking some plants off and removing some roots as well. Specially designed aquatic plant rakes are available. Rakes can be equipped with floats to allow easier plant and fragment collection. The operator should pull towards the shore because a substantial amount of plant material can be collected in a short distance.

### Cleanup

All of the manual control methods create plant fragments. It's important to remove all fragments from the water to prevent them from re-establishing or drifting onshore. Plants and fragments can be composted or added directly to a garden.

### Advantages

- Manual methods are easy to use around docks and swimming areas.
- The equipment is inexpensive.
- Hand-pulling allows the flexibility to remove undesirable aquatic plants while leaving desirable plants.
- These methods are environmentally safe.
- Manual methods don't require expensive permits, and can be performed on aquatic noxious weeds with Hydraulic Project Approval obtained by reading and following the pamphlet *Aquatic Plants and Fish* (publication #APF-1-98) available from the Washington Department of Fish & Wildlife.

### Disadvantages

- As plants re-grow or fragments re-colonize the cleared area, the treatment may need to be repeated several times each summer.
- Because these methods are labor intensive, they may not be practical for large areas or for thick weed beds.
- Even with the best containment efforts, it is difficult to collect all plant fragments, leading to re-colonization.
- Some plants, like water lilies, which have massive rhizomes, are difficult to remove by hand pulling.

- Pulling weeds and raking stirs up the sediment and make it difficult to see remaining plants. Sediment re-suspension can also increase nutrient levels in lake water.

- Hand pulling and raking impacts bottom-dwelling animals.

- The V-shaped cutting tool is extremely sharp and can be dangerous to use.

### Permits

Permits are required for many types of manual projects in lakes and streams. The Washington State Department of Fish and Wildlife requires a *Hydraulic Project Approval* permit for all activities taking place in the water including hand pulling, raking, and cutting of aquatic plants.

### Costs

- Hand-pulling costs up to $130 for the average waterfront lot for a hired commercial puller.
- A commercial grade weed cutter costs about $130 with accessories. A commercial rake costs about $95 to $125. A homemade weed rake costs about $85 (asphalt rake is about $75 and the rope costs 35-75 cents per foot).

### Other Considerations

Does the community want to invest in weed rakes, other equipment? Manual methods must include regular scheduled surveys to determine the extent of the remaining weeds and/or the appearance of new plants after eradication has been attained.

### Suitability for Lake Osoyoos

- These methods will be important after the initial herbicide application, after the chemical control methods have been evaluated for their effectiveness.

- Manual methods will also be vital in combating new infestations of Eurasian watermilfoil in subsequent years, especially around access areas.

- The currently infested areas are too large to use manual techniques as the sole source of control for Eurasian watermilfoil and most other noxious weeds. Costs would be much higher than for an integrated approach.

- Manual methods have the potential for missing Eurasian watermilfoil plants, especially after stirring up sediments.

- Manual methods have the potential for fragmentation, exacerbating the existing Eurasian watermilfoil problem.

- Cutting can be used to control small areas of fragrant water lily, especially those close to the shoreline. Using this method out in the open water would require a stable boat (not canoe) and great care not to injure oneself or another passenger. Since repeated cutting over several seasons may be required to starve the roots, this would fit best as a supplement to other control methods.

- Many landowners have already been manually removing their loosestrife for several seasons. This does not kill the mature perennial plants, but does halt seed production and can contain the infestation at current levels. If done repeatedly over several seasons it should starve the roots and kill the plants.

## BOTTOM BARRIERS

Bottom Barriers and screening have been discussed extensively with landowners around the lake and have been discarded as a control option for much of the lake. Since the water levels do not fluctuate much, and due to the continual re-infestation from Canadian harvesting activities, the expense of installation and continued maintenance of Bottom Barriers is not a cost effective management tool at this time.

## DIVER DREDGING

Diver dredging (suction dredging) is a method whereby SCUBA divers use hoses attached to small dredges (often dredges used by miners for mining gold from streams) to suck plant material from the sediment. The purpose of diver dredging is to remove all parts of the plant including the roots. The suction hose pumps the plant material and the sediments to the surface where they are deposited into a screened basket. The water and sediment are returned back to the water column (if the permit allows this), and only the plant material is retained. The turbid water is generally discharged to an area curtained off from the rest of the lake by a silt curtain. The plants are disposed of on shore. Diver dredging is more effective in areas where softer sediment allows easy removal of the entire plants, although water turbidity is increased with softer sediments.

According to the DOE website, "Sites suitable for diver dredging include lakes or ponds lightly to moderately infested with milfoil. Because diver dredging can be very expensive, this method is most suitable for moderate to early infestations of milfoil and for follow-up milfoil removal after an herbicide treatment. Diver hand pulling is more effective in lightly scattered patches of milfoil, whereas diver dredging may be more appropriate in denser milfoil beds. Diver dredging may also be applicable in water bodies where no herbicide use can be tolerated. Theoretically diver dredging could be used in any waterbody to eradicate milfoil; however the costs for large scale projects would become astronomical."

Diver dredging may be a suitable management method in some instances on this body of water. Those situations would typically include situations in deeper/moving water, where herbicide applications would not be effective. However, the dense infestations of Eurasian watermilfoil found in most parts of the lake make this option unfeasible at this time.

## BIOLOGICAL CONTROL

Bio control agents have been historically used on Lake Osoyoos for control of Purple Loosestrife. While the agents are effective, the minor fluctuations in water level do not readily contribute to establishment of weevil populations. Ongoing and continual releases have shown some effective control.

The native Northern watermilfoil is the intended host for the milfoil weevil. However, this weevil has shown a preference for the non-native Eurasian watermilfoil. While the weevil is established in the Lake, it is not present in densities necessary to control E. milfoil.

The LOA, with assistance from DOE, has initiated a pilot project to establish rearing guidelines allowing propagation of weevils by interested parties. The pilot project consisted of purchasing the necessary equipment, tanks, aerators, etc., collecting weevils and sufficient E. milfoil to provide habitat and food source, and following the progress in the local high school science lab. The weevils, including progeny were released into the lake in 3

weeks. LOA revisited the release site to monitor any results from the re-introduction and noted a definite lowering of milfoil stems in the water column.

Grass carp have been suggested for use in milfoil control efforts, but the lack of specificity may lead to declines in native vegetation that would use nutrients in the lake, and provide competition for resources by the E. milfoil.

Advantages

- Bio control methods are long term, providing some level of control.
- The agents are inexpensive, once approved for re-distribution through APHIS, or native as in the case of the milfoil weevil.
- These methods are environmentally safe, with minimal or no effect on off target species.

Disadvantages

- Bio controls are not effective at eradication efforts,
- They take a significant amount of time to become established at densities needed to provide sufficient control.
- They are expensive to get approved through APHIS for initial release.

Permits
No permits are needed for approved bio-control releases.

Costs

- Approximately $120 to set up equipment to rear E milfoil weevils, though the collection process is very time consuming.
- At this time Purple loosestrife bio controls are distributed at no charge through a partnership with WSU Extension. But should that aspect change, bio controls are typically available for approx. $1/agent.

**Suitability for Lake Osoyoos**

- These methods will be important after the initial herbicide application, after the chemical control methods have been evaluated for their effectiveness.
- Bio controls will be useful in combating new infestations of Eurasian watermilfoil in subsequent years.
- The currently infested areas are too large to use bio agents as the sole source of control for Eurasian watermilfoil and other noxious weeds.
- Grass Carp are unsuitable for release in the Lake due to the lack of target specificity.

## MECHANICAL

Harvesting and rototilling are options frequently used for aquatic vegetation control efforts. Both methods are used on the Canadian side of the lake to control non-native milfoil infestations.

Mechanical harvesters are large machines which both cut and collect aquatic plants. Cut plants are removed from the water by a conveyor belt system and stored on the harvester until disposal. A barge may be stationed near the harvesting site for temporary plant storage or the harvester carries the cut weeds to shore. The shore station equipment is usually a shore conveyor that mates to the harvester and lifts the cut plants into a dump truck. Harvested weeds are disposed of in landfills, used as compost, or in reclaiming spent gravel pits or similar sites.

Harvesting is usually performed in late spring, summer, and early fall when aquatic plants have reached or are close to the water's surface. Harvesters can cut and collect several acres per day depending on weed type, plant density, and storage capacity of the equipment. Harvesting speeds for typical machines range from 0.5 to 1.5 acres per hour. Depending on the equipment used, the plants are cut from five to ten feet below the water's surface in a swath 6 to 20 feet wide. Some modern harvesters can cut plants in a range of water depths. Because of machine size and high costs, harvesting is most efficient in lakes larger than a few acres. Harvesting can be an excellent way to create open areas of water for recreation and fishing access.

Along with plants, harvesters also collect a large number of small fish and invertebrates. Amphibians and turtles have been known to be collected as well.

**Advantages**

- Harvesting results in immediate open areas of water.
- Removing plants from the water removes the plant nutrients, such as nitrogen and phosphorus, from the system.
- Harvesting as aquatic plants are dying back for the winter can remove organic material and help slow the sedimentation rate in a waterbody.
- Since the lower part of the plant remains after harvest, habitat for fish and other organisms is not eliminated.
- Harvesting can be targeted to specific locations, protecting designated conservancy areas from treatment.

**Disadvantages**

- Harvesting is similar to mowing a lawn; the plant grows back and may need to be harvested several times during the growing season.
- There is little or no reduction in plant density with mechanical harvesting.
- Off-loading sites and disposal areas for cut plants must be available. On heavily developed shorelines, suitable off-loading sites may be few and require long trips by the harvester.
- Some large harvesters are not easily maneuverable in shallow water or around docks or other obstructions.
- Significant numbers of small fish, invertebrates, and amphibians are often collected and killed by the harvester.
- Harvesting creates plant fragments which may increase the spread of invasive plant species such as Eurasian watermilfoil throughout the waterbody.
- Although harvesters collect plants as they are cut, not all plant fragments or plants may be picked up. These may accumulate and decompose on shore, often forming new infestations.
- Harvesters are expensive and require routine maintenance.
- Harvesting may not be suitable for lakes with many bottom obstructions (stumps, logs) or for very shallow lakes (3-5 feet of water) with loose organic sediments.

- Harvesters brought into the waterbody from other locations need to be thoroughly cleaned and inspected before being allowed to launch. Otherwise new exotic species could be introduced to the waterbody.

**Permits**

Harvesting in Washington requires hydraulic approval from the Department of Fish and Wildlife. Some Shoreline Master Programs may also require permits for harvesting, but in Okanogan County that is not the case. Because harvesting collects fish along with aquatic plants, some additional monitoring may be required when harvesting in salmon bearing waters.

**Costs**

Costs per acre vary with numbers of acres harvested, accessibility of disposal sites to the harvested areas, density and species of the harvested plants, and whether a private contractor or public entity does the work. Private contractors generally charge $500 to $800 per acre. The purchase price of harvesters ranges from $35,000 to $110,000. There are several harvester manufacturers in the United States and some lake groups may choose to operate and purchase their own machinery rather than contracting for these services.

**Rotovation:**

A rotovator is a barge-mounted rototilling machine that lowers a tiller head about eight to ten inches into the sediment to dislodge milfoil root crowns. The mechanical agitation produced by the tiller blades dislodges the root crowns from the sediment and the buoyant root masses float to the water surface. Since the entire plant is removed, plant biomass remains reduced in the treatment area throughout the growing season and often longer. Rotovation often provides two full seasons of control (Gibbons et. al, 1987). Unlike harvesters, rotovators do not have the capability to collect the plants.

Rotovation is a way to mechanically remove milfoil to provide open areas of water for recreational activities and navigation. Waterbodies suitable for rotovation include larger lakes or rivers with widespread, well-established milfoil populations where milfoil eradication is not an option. Since on-going rotovation programs are very expensive, having a large lake population or a motivated local government to share these costs is crucial. Because rotovation is expensive and multiple permits are needed, rotovation has not become a wide-spread milfoil control activity in Washington or elsewhere in the United States.

Rotovation is not recommended in water bodies with early infestations of milfoil since fragments are created and rotovation may increase the spread of milfoil throughout the waterbody. Because rotovation creates turbidity, rotovation may not be appropriate in salmon-bearing waters, although sometimes Fish and Wildlife staff are able to provide windows of time when rotovation activities will have the least impact on fish. Because rotovation and the resultant turbidity may impact the entire waterbody, it should be conducted under the direction of an integrated aquatic vegetation management plan.
Rotovation requires a Hydraulic Project Approval from Fish and Wildlife.

Factors to consider when designing a rotovation program include:
•Waterbody surface area, width, and depth.
•Vegetated acres.
•Bottom contours and bottom obstructions such as stumps, rocks, and other debris.
•Traffic patterns.
•Prevailing winds.
•Rotovator launching and off-loading sites.
•Sediment type.

•Shoreline development.
•Sensitive areas (critical habitat).

A waterbody committee and/or local government staff should identify acreages and areas to be rotovated. Priorities may be determined by who funds the program. A local government will be more interested in rotovating public areas, whereas local residents may be interested in rotovating areas in front their homes. However, generally high use areas such as public parks, community access points, navigation channels, public boat launches, and water ski lanes receive priority. Sometimes rotovators can be used to create fishing lanes in dense beds of milfoil to provide better fishing access to anglers.

Prior to rotovation, machinery launch sites (a paved ramp with deep water is best) need to be identified. Since rotovators do not collect plants as they work, a method for removing plants from the water should be developed. This may involve having a harvesting machine follow behind the rotovator to collect plants or hiring people to rake plants off beaches. Rotovation activities should begin at the farthest point up stream. The plants are then carried downstream and get caught up on the remaining dense milfoil beds.

During a rotovation project, the rotovator tilling head is lowered into the sediment and power is applied. The rotating head churns into the sediment dislodging milfoil root crowns and plants, and a plume of sediments. The rotovated plants eventually sink or wash up on shore and the sediments gradually settle from the water. Canadian plant managers have recorded milfoil stem density and root crown reductions of better than 99 percent after rotovation test trials (British Columbia Ministry of Environment memo dated 1991). Where repeated treatments have occurred at the same site over several consecutive years, treatment intervals may extend longer than two years (Gibbons, et. al, 1987).

In a few waterbodies such as in the Pend Oreille River, rotovation may be performed year-round. In most water bodies, timing is dependent on fish windows. Washington Fish and Wildlife does not want rotovation activities to take place when fish are spawning or juvenile salmon are migrating through the waterbody.

For efficacy of milfoil removal, it's best to begin operations in early spring and resume again in the fall. Rotovation is less effective in the summer when the long milfoil plants wrap around the rotovating head, slowing down the operation. If rotovation is done during the summer, it is more efficient to cut or harvest the plants beforehand. Weather creates winter rotovation delays, although it is possible to rotovate throughout the winter months (as long as the waterbody doesn't freeze). Delays in the rotovation schedule can result from high winds, thunderstorms, freezing water, and mechanical failure. There is a lot of maintenance and some down time on machinery working on the water.

Complaints about rotovation include increased plant fragments washing up along shorelines, broken water intakes, it is important to establish some clear guidelines and policies to help make decisions and to settle disputes.

General impacts of rotovation:

- Rotovators stir sediments into the water column. In addition to the sediments, buried toxic materials and/or nutrients may be released.

- Generally turbidity is short-term and the water returns to normal within 24 hours, but the length of time that sediments remain suspended depends on sediment type.

- Plants and root crowns are uprooted from the sediment and unless a plant removal plan is in place, these plants will either sink or be washed on shore.

- Rotovation appears to stimulate the growth of native aquatic plants. Whether this is due to the removal of milfoil, the action of the rotovator stimulating seed or propagule germination, or a combination of these factors is not known.

- Rotovators are also large machines with hydraulic systems and fuel that occasionally leaks or is spilled. The operator should have a spill plan and containment equipment on board for emergency use.

In 1987, Ecology conducted an evaluation of rotovation in Lake Osoyoos. This lake was chosen because it has a history of mining and agricultural use and therefore might represent a "worst case" scenario in terms of the potential for release of contaminants from sediment. The objectives of the study were to document effectiveness of rotovation by measuring changes in milfoil stem densities before and after treatment, and to assess impacts of rotovation on selected water quality parameters, benthic invertebrates, and the fisheries. Although the rotovator malfunctioned during the test (the hydraulic system driving the rototiller was not functioning properly), the results were consistent with data collected by the British Columbia Ministry of the Environment of sites rotovated by a fully operating rotovator. During the Lake Osoyoos rotovator test, rotovation appeared to have little impact on fish, water quality, or benthic invertebrates. However during this test, milfoil stem densities were not reduced to the extent that should have occurred had the machinery been operating properly. Although the results indicated only short-term impacts associated with rotovation, the test was faulty and it is difficult to draw firm conclusions. This study was not repeated.

**CONCLUSION**

Lake Osoyoos covers an international border and is home to a variety of fish, birds, and other wildlife. It offers a vast array of activities, such as fishing, boating and swimming. A variety of interests will drive the Integrated Aquatic Vegetation Management Plan. No one control method will work for every aspect of the lake. Therefore we will use a truly integrated approach based upon the individual shore owners' needs and the needs of the lake at individual sites.

Many landowners have already begun chemical treatments to reduce the Eurasian watermilfoil infestations along their shore area. These activities have been performed by licensed applicators using the aquatic labeled herbicides available in Washington State. Restrictions were originally placed on the Permit, disallowing herbicide use within a quarter mile of the international border. These restrictions remain in place at this time, and applications are limited to 10 acres. The Noxious Weed Board will work to increase the acreage limitations based on needs by lake shore residents.

Others will continue to experiment with weevil rearing and attempt to improve upon the collection process. In 2013, WSU Extension Douglas County assisted in the collection of debris from the shoreline to determine if that was a viable collection process. Weevils were found in the debris, but not in sufficient quantities to make it effective. The collection process will be attempted again in 2014, trying different timing windows and distance from water. The tanks and equipment provided through the DOE planning grant have been made available to the Oroville High School, OCNWCB, and interested residents, to both propagate additional weevils and use as an educational tool.

Raking of milfoil and removal of debris from along the shore will be sufficient in some areas. This has been the preferred method for many landowners with limited infestations. The ease of constructing a rake or hoe to collect milfoil, the limited expense, and availability of rakes and hoes, has increased its popularity. Landowners who prefer to rake and remove debris from the lake will be encouraged to allow the debris to rest on the shoreline for several days to allow weevil migration back to the water.

Talks will continue with Canada to explore the possibility of utilizing their harvester south of the border. While the harvester will not effectively control the aquatic vegetation, it will allow for safer recreation.

While the main emphasis of control efforts will change from landowner to landowner, the objective of all lake owners is to reduce infestations of Eurasian watermilfoil and other aquatic noxious weeds to a level that is tolerable, promotes an increase functionality of habitat for fish and aquatic organisms, and provides a safe environment for recreation and other uses of the lake.

**Table 1:**

# PLANT SPECIES AS PER DOE SURVEYS

| Scientific name | Common name |
|---|---|
| Carex sp. | sedge |
| Ceratophyllum demersum | Coontail; hornwort |
| Chara sp. | muskwort |
| Eleocharis sp. | spike-rush |
| Elodea canadensis | common elodea |
| Equisetum sp. | horse tail |
| Heteranthera dubia | water star-grass |
| Iris pseudacorus | yellow flag |
| Juncus sp. or Eleocharis sp. | small grass-like plants |
| Lythrum salicaria | purple loosestrife |
| Myriophyllum sibiricum | northern watermilfoil |
| Myriophyllum spicatum | Eurasian water-milfoil |
| Najas flexilis | common naiad |
| Nymphaea odorata | fragrant waterlily |
| Phalaris arundinacia | reed canarygrass |
| Potamogeton crispus | curly leaf pondweed |
| Potamogeton foliosus | leafy pondweed |
| Potamogeton gramineus | grass-leaved pondweed |
| Potamogeton illinoensis | Illinois pondweed |
| Potamogeton natans | floating leaf pondweed |
| Potamogeton nodosus | longleaf pondweed |
| Potamogeton richardsonii | Richardson's pondweed |
| Potamogeton sp (thin leaved) | thin leaved pondweed |
| Potamogeton zosteriformis | eel-grass pondweed |
| Ranunculus aquatilis | water-buttercup |
| Ranunculus flammula | creeping buttercup |
| Sagittaria sp. | arrowhead |
| Schoenoplectus acutus | hardstem bulrush |
| Schoenoplectus sp. | naked-stemmed bulrush |
| Schoenoplectus tabernaemontani | softstem bulrush |
| Solanum sp. | nightshade |
| Stuckenia pectinata | sago pondweed |
| Stuckenia sp. | pondweed |
| Typha latifolia | common cat-tail |
| Utricularia sp. | bladderwort |
| Vallisneria americana | water celery |
| Zannichellia palustris | horned pondweed |


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Conclusion:"

Lake Osoyoos has been experiencing widespread milfoil growth since the late 1070's. Much of this has come downstream from the Canadian side to the United States side and spread throughout the Okanogan River watershed and into the Columbia River. While milfoil has many

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sources this fact has significantly spread milfoil throughout this watershed."

From our last invasive weed survey (Sept 2013) the current levels of milfoil on the U.S. side of Osoyoos stands at 90acres (see picture above). Local estimates of milfoil in the lake are

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somewhat higher. "

Unless action is taken to reclaim our lake the milfoil and other invasives will continue to spread throughout the lake and downstream in the watershed. Since 1984 the Canadians have preferred and regularly use mechanical means of control like mechanical harvesting and rotovating. This along with fragmentation by ski and wake board boats, along with other

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recreational water users will only contribute to the spread of Eurasian Watermilfoil. "

The lakeshore residents and other recreational users from the U.S. side of the lake want significant action to reclaim their lake. The Lake Osoyoos Association (LOA) is a thirty some member organization. Currently there are 18 lake shore owners who want an herbicide

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application during the summer of 2014."

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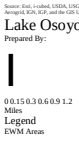
After much research and investigation the LOA supports and recommends the following actions:"

1. Herbicide application using Washington Department of Ecology approved list. This may involve more than one herbicide, since what can be used in the more southern part of the lake may be different that what can be used closer to the International Border with Canada (outside of the 1/4 mile buffer zone).This method is becoming the preferred method of

control amongst a majority of residents. Initially, in June of 2013 we had 10 lakeshore residents sign up for herbicide application. With increased education through monthly newsletters that number has increased to 18 lake shore owners. We believe that this number will continue to increase. "




2. After initial treatment continue to monitor treated milfoil patches. With new growth, or " spotty results in these areas consider the possibility of physical treatment using scuba divers " to hand pull more of the roots in these areas, and or follow-up spot reapplication of " herbicides."

3. For near shore zones where herbicide treatment has been spotty consider the possibility of a " Bethnic Barrier pilot trial. If this is proven to have any success this non-herbicide " treatment could be shared with the Canadians to hopefully lessen their reliance on " harvesting. "

4. Rakes could be used only during the early to mid fall seasons when the lake level is drawn " down below 911.5 feet. Much education would need to be given to interested lakeshore " owners who have significant milfoil patches close to their near shoreline. This education " would focus on capturing their raked milfoil waste and disposing of it in their recycling or " compost."

5. Continued education regarding Clean-Drain-Dry. Continued education on identifying " Eurasian Watermilfoil and other invasives to local residents through multiple means including " newspaper articles, public forums, signage, and having short videos posted on our website. "